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Original Article

Validation study of REM Sleep Behavior Disorder Questionnaire – Hong Kong (RBDQ-HK) in East China

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ABSTRACT

Objective: To validate the REM Sleep Behavior Disorder (RBD) Questionnaire – Hong Kong (RBDQ-HK) in polysomnography (PSG)-confirmed RBD and non-RBD subjects, and to evaluate its usefulness in different clinical populations.
Methods: In total, 325 subjects (115 RBD and 210 controls) from East China were enrolled. After patients had finished the structured interview, and completed the RBDQ-HK and video-PSG test, we evaluated the reliability of RBDQ-HK (areas under the curves (AUC), the best cut-off values, factor 2 of RBDQ-HK, and overall scale) and validated the usefulness of RBDQ-HK between the Parkinson disease (PD) and obstructive sleep apnea (OSA) groups.
Results: The best cut-off values for factor 2 of RBDQ-HK were located at 7/8 with a sensitivity of 90% and specificity of 82% (AUC = 0.911), and for RBDQ-HK overall scale were located at 17 with a sensitivity of 85% and specificity of 81% (AUC = 0.892) in all subjects. Both factor 2 and overall scale of RBDQ-HK are valid in all subjects (PD and OSA patients), with a higher accuracy given by factor 2 of RBDQ-HK.
Conclusions: RBDQ-HK and its factor 2 are useful and validated RBD screening instruments, and could be used as a tool for screening RBD in patients with PD and OSA.

1. Introduction

Rapid eye movement (REM) sleep behavior disorder (RBD) is characterized by intermittent loss of REM sleep electromyographic (EMG) atonia and appearance of elaborate motor activity associated with dream mentation [1]. RBD has been increasingly recognized as a specific predictor for neurodegenerative disorder. Many prospective and cross-sectional studies reveal that quite a number of idiopathic RBD (iRBD) patients will develop into neurodegenerative diseases such as Parkinson disease (PD) after several years or decades [2–4], and iRBD patients share similar changes with neurodegenerative diseases in pathological, clinical, and ancillary test findings [3,5–8]. RBD should be screened as early as possible and followed up.

According to the second edition of the International Classification of Sleep Disorders (ICSD-II), polysomnography (PSG) is essential to establish the criterion for the diagnosis of RBD; however, it is costly, labor intensive, and impractical to perform in large numbers of subjects. Some available subjective and objective clinical tools have been used for RBD assessment [9]. A few RBD screening questionnaires have been designed to facilitate population-based studies and future neuroprotective studies. These screening questionnaires contain: Mayo Sleep Questionnaire (MSQ) whose validation study yielded a sensitivity of 98% and specificity of 74% [10]; the REM sleep behavior disorder screening questionnaire (RBDSQ) of which the sensitivity and specificity are moderate (sensitivity: 84–96%; specificity: 56–96%) at the cut-off value of 5 points in general population and 6 points in PD patients [11–13]; the RBD Single-Question Screen (RBD1Q) whose validity had been examined in an international multicentre case–control study with good sensitivity (93.8%) and specificity (87.2%) [14]; and the Innsbruck RBD inventory (RBD-I) with a cut-off score of 0.25, showing excellent sensitivity and specificity (91.4% and 85.7%, respectively) [15].

The above-mentioned scales may not keep in mind the variation of severity of RBD nocturnal behaviors, and so may overlook the

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frequency and severity of RBD symptoms. For these reasons the REM Sleep Behavior Disorder (RBD) Questionnaire – Hong Kong (RBDQ-HK) was developed and certified originally by Li et al. [16], with moderate sensitivity (82.2%, 87.9% respectively) and specificity (86.9%, 81.3% respectively) using a cut-off value of 17/18 points on overall scale and 7/8 points on subscale (factor 2 of RBDQ-HK). In 2012, Sasai et al. found that the best cut-off point for the Japanese version of the RBDQ-JP total score was 19/20, with a sensitivity of 97.2% and specificity of 97.5%, but the control subjects did not undergo PSG [17]. Their work demonstrated that RBDQ (RBDQ-HK and RBDQ-JP) had satisfactory reliability and validity as a tool for screening and modifying severity of RBD.

However, there are still some limitations on the validity studies of RBDQ. First, there are only two validation studies until now, and they have not been fully validated. Second, some subjects were not PSG-confirmed, which might decrease the accuracy of diagnosis. Third, as a screening tool, it was expected that RBDQ would identify RBD patients in different clinical populations, such as those with comorbid neurodegenerative and psychiatric disorders, but this has not yet been achieved. Based on these reasons, we assessed the reliability and validity of RBDQ in all PSG-confirmed RBD subjects and non-RBD subjects in East China, and further validated the questionnaire in different clinical populations.

2. Methods

2.1. Subjects

Patients with neurological diseases, psychiatric diseases, sleep-related disorders, and undergoing health check-up were recruited from the Sleep Center of the Second Affiliated Hospital, Soochow University from August 2011 to March 2013. The local ethics committee of the hospital approved the study, and the patients signed informed consent forms for the investigation. Patients whose handwriting in the questionnaire was illegible and who failed to attain REM sleep on their video-PSG were excluded from the study.

2.2. REM Sleep Behavior Disorder Questionnaire – Hong Kong (RBDQ-HK)

The RBDQ-HK questionnaire is a 13-item patient self-administered questionnaire pertaining to various clinical features of RBD. Each item is assessed on two scales: lifetime occurrence (don't know, yes, or no) and recent one-year frequency (occurred in the last year, once or few times per year, once or few times per month, one or two times per week, and three times or more per week). It comprises factor 1 (Q1–Q5, and Q13, dream-related factor) and factor 2 (Q6–Q12, behavioral factor). Different factors have different weighted scores according to the clinical importance of manifestations of RBD. The total RBDQ-HK score was calculated by the sum of the scores of the two factors, ranging from 0 to 100 [16].

2.3. Polysomnographic recordings

All PSG recordings were collected and stored digitally using the Sandman Elite sleep diagnostic system (Embla Systems, Denver, CO, USA) or Compumedics E-Series PSG Recording System (Compumedics Limited, Australia), containing following montages: bilateral electro-oculogram (EOG) derivations, standard electroencephalographic (EEG) derivations (C3–A2, C4–A1, O1–A2, O2–A1), electrocardiogram, chin and two upper and lower limb surface EMG derivations (right and left anterior tibial, and right and left extensor digitorum communis), oronasal airflow by thermocouple and nasal pressure measurements, sonogram, oxyhemoglobin saturation, and chest and abdomen inductance plethysmography. All PSG data were recorded in synchrony with continuous video monitoring.

2.4. Procedure

Experienced neurologists performed the evaluations and completed neurological examinations of the inpatients and outpatients. After finishing the structured interview and having given informed consent, patients were arranged to undergo video-PSG test and asked not to take any drugs on the night they underwent PSG. The RBDQ-HK questionnaire was administrated to patients 30 min before PSG test. Because RBDQ-HK was composed by dream-related items which the patient self-knew better, and behavioral items which the patient's bed partner knew better, the patient and her/his bed partner were encouraged to complete the questionnaires together. Fifty random patients were asked to complete a second set of the questionnaire spaced four weeks apart from the first assessment to measure the test–retest reliability. All PSGs were reviewed by one sleep specialist who was blinded to the results of the interview and questionnaire in our sleep center. The Montplaisir group's slightly modified RBD PSG scoring method (RPSM) was used to define REM sleep without atonia (RSWA) [18,19]. Details are listed as follows: sleep stages 1–4 were scored according to the method of Rechtschaffen and Kales, using 20 s epochs. REM sleep was scored on the basis of EEG and EOG only. The occurrence of the first REM epoch was used to determine the onset of a REM sleep period. The termination of REM sleep periods was identified by the occurrence of an EEG feature indicative of another stage (*K* complex, sleep spindle, or EEG sign of arousal) or by the absence of rapid eye movements during three consecutive minutes. According to the published method, patients whose chin EMG tonic density was $\geqslant$30% or phasic chin EMG density was $\geqslant$15% were considered to meet the PSG criteria of RBD. All REM tone quantification carefully eliminates apnea-associated arousals. Moderate to severe obstructive sleep apnea (OSA) patients (AHI $\geqslant$ 15/h) who fulfilled the PSG criteria of RBD at their first PSG test were booked to have a second PSG test while using continuous positive airway pressure (CPAP) to eliminate 'pseudo-RBD' [20].

According to diagnostic criteria of RBD in ICSD-II, patients were divided into RBD group and control group. First, RBDQ-HK was validated in all subjects, and then in different clinical populations. RBD patients were subclassified into iRBD group that occurs in the absence of any other obvious associated neurological disorders, symptomatic RBD (sRBD) group that occurs with neurodegenerative diseases such as PD or narcolepsy, and RBD-like disorder group that occurs with psychotropic medications or psychiatric illness. The internal consistency (estimated by Cronbach's α coefficient) and test–retest reliability [estimated by intra-class correlation (ICC)] were employed to assess the reliability, and area under the receiver operating characteristics (ROC) curve (AUC), optimal cut-off values, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were employed to assess the validity. The features of behavioral aspects and dream aspect of RBD in three RBD subgroups were assessed by comparing questionnaire factor scores.

2.5. Statistical analyses

All analyses were performed using SPSS version 19.0 for Windows. Patients' demographic and clinical data were presented with descriptive statistics. Measurement data were reported as means ± SD (standard deviations). Non-parametric tests were used for two independent samples. Mann–Whitney *U*-test was employed to assess the differences among groups. $P < 0.05$ was considered statistically significant. Both Cronbach's α coefficient

and ICC ⩾ 0.7 were considered satisfactory [21], and AUC ⩾ 0.70 was considered adequate [22].

3. Results

In total, 338 patients completed RBDQ-HK and underwent video-PSG. About 10 patients whose handwriting was illegible and three patients who failed to attain REM sleep on their PSG were excluded from the study. Of remaining 325 patients, 18 moderate to severe OSA patients fulfilled the PSG criteria of RBD at their first PSG test, 13 of whom were demonstrated to be bona fide OSA-RBD patients after undergoing a second PSG test while using CPAP. Therefore 115 RBD patients (mean age, 59.13 ± 15.7 years; male, 67.8%) and 210 control subjects (50.49 ± 16.3 years; male, 68.6%) were included. About 281 (86.46% of all subjects) patients completed the RBDQ-HK by both themselves and their bed-partners (96, 83.48% in case group and 185, 88.10% in control group), and 44 subjects (13.54% of all subjects) completed the RBDQ-HK by themselves only (n = 19, 16.52% in case group; n = 25, 11.9% in control group). In the RBD group, there were 48 iRBD patients, 61 sRBD patients (all associated with PD), and six RBD-like disorder patients. In the control group, neurodegenerative disorder and other sleep–wake disturbances were present and assigned to the following diagnoses: PD (n = 34), psychiatric disorder (n = 40, most of them suffer from anxiety and depression), obstructive sleep apnea syndrome (OSA, n = 114), excessive daytime sleepiness (n = 10), healthy people (n = 12). In total, 95 PD patients, 144 OSA patients and 46 psychiatric disorder patients were included in the study (Table 1).

In all 325 patients, RBD group had a significantly higher score for RBDQ-HK factor 2 and RBDQ-HK overall scale than control group (factor 2: 26.01 ± 16.20 vs 4.02 ± 7.09; overall scale: 38.40 ± 21.65 vs 9.94 ± 10.29, respectively) (P < 0.001; Table 2). ROC curve (Fig. 1) revealed that both factor 2 of RBDQ-HK and the overall scale had good diagnostic accuracy (AUC = 0.911, 0.892, respectively) in all subjects. The best cut-off values were located at 7 or 8 points on RBDQ-HK factor 2 with a sensitivity of 90.43%, specificity of 82.38%; and 17 points on RBDQ-HK overall scale with a sensitivity of 84.35%, specificity of 80.95% (Table 3).

In all PD patients (n = 95), those with RBD had a significantly higher score for RBDQ-HK factor 2 and RBDQ-HK overall scale than those in PD without RBD (factor 2, 29.30 ± 16.20 vs 8.79 ± 10.05; overall scale: 42.07 ± 21.54 vs 15.71 ± 14.96, respectively) (P < 0.001; Table 2). ROC curve (Fig. 2) revealed that both factor 2 of RBDQ-HK and the overall scale had good diagnostic accuracy (AUC = 0.861, 0.840, respectively) in PD patients. Furthermore, the best cut-off values were located at 13 points on RBDQ-HK factor 2 with sensitivity of 83.6%, specificity of 76.5%; and at 18 points on RBDQ-HK overall scale with a sensitivity of 86.9%, specificity of 70.6% (Table 3).

Table 1
Demographic and clinical data.

	Case group	Control group
No. of subjects	115	210
Age (years, mean ± SD)	59.13 ± 15.7	50.49 ± 16.3
Gender (male)	78 (67.8%)	144 (68.6%)
Questionnaire responses informant		
Self + bed-partner	96 (83.48%)	185 (88.10%)
Patient self	19 (16.52%)	25 (11.90%)
Comorbid disorders		
Parkinson disease	61 (53.04%)	34 (16.19%)
Psychiatric disorder	6 (5.22%)	40 (19.05%)
Obstructive sleep apnea syndrome	30 (26.09%)	114 (54.29%)
Excessive daytime sleepiness	–	10 (4.76%)
Healthy people	–	12 (5.71%)

In all OSA (n = 144), the patients with RBD had a significantly higher score for RBDQ-HK factor 2 and RBDQ-HK overall scale than those without RBD (factor 2: 17.33 ± 13.49 vs 3.09 ± 6.05; overall scale: 26.33 ± 18.1 vs 8.23 ± 8.31, respectively) (P < 0.001; Table 2). ROC curve (Fig. 3) revealed that both factor 2 of RBDQ-HK and the overall scale had good diagnostic accuracy (AUC = 0.878, 0.850, respectively) in OSA patients. The best cut-off values were located at 7 points on RBDQ-HK factor 2 with a sensitivity of 83.3%, and specificity of 87.7%; and at 17 points on RBDQ-HK overall scale with a sensitivity of 70.0%, and specificity of 86.8% (Table 3).

Among RBD subgroups, sRBD group scored the highest on factor 1, factor 2, and overall scale; whereas the RBD-like disorder group scored the lowest (sRBD, 12.77 ± 7.21, 29.30 ± 16.20, and 42.07 ± 21.54; iRBD, 12.19 ± 8.27, 23.29 ± 15.89, and 35.48 ± 21.55; RBD-like disorder, 10.17 ± 8.11, 14.33 ± 9.59, and 24.50 ± 16.56, on factor 1, factor 2, and overall scale, respectively). Mean score of factor 2 and overall scale was significant between sRBD group and RBD-like disorder group (P < 0.05; Table 2). Cronbach's α coefficient for overall scale was 0.83, and ICC for overall scale was 0.88, showing that RBDQ-HK was reliable.

4. Discussion

The main finding from this study is that RBDQ-HK, especially RBDQ-HK factor 2, is a useful and validated RBD screening instrument, and that PD patients may have higher cut-off values for this scale.

In PD patients, the cut-off value for factor 2 of RBDQ-HK was 6 points higher than that in all subjects or OSA patients (Table 3). The possible reasons are: (1) PD patients may present arousal-related motor–behavioral episodes (AMBEs) arising from NREM sleep more frequently than non-PD patients [23,24]. Questions 6–12 (RBDQ-HK factor 2) ask questions about sleep enactment behaviors (SEBs), not merely RBD, but also AMBEs from NREM or REM sleep, which may only be distinguished by video-PSG monitoring. If AMBEs present more frequently in PD patients, they may obtain higher factor 2 scores than non-PD patients, resulting in a higher cut-off value in PD patients. (2) The PSG gold standard cut-offs for REM atonia in PD patients might be different. As far as we knew, there were no cut-off values of REM atonia to diagnose PD patients with RBD, so we used the most widely accepted PSG criteria for diagnosis of RBD, i.e. PSG findings of either tonic chin EMG activity ⩾30% of REM sleep, or phasic chin EMG activity ⩾15% of REM sleep. It is worth considering that the criteria were originally established for iRBD patients, not for sRBD patients [18]. Sleep disturbances are among the most common non-motor symptoms in PD patients, with a prevalence ranging from approximately 40–90%, including insomnia, restless legs syndrome, OSA, and so on [25]. These non-specific sleep problems, which include snoring, speaking, swallowing, CPAP background noise, and breathing, may influence true chin EMG activity. There was a high incidence of OSA in PD patients (approximately 20–60%) [26,27], and they might have non-specific types of REM atonia due to upper airway muscle dysfunction. Some unrecognized arousals were associated with increased tone. We speculated that PD patients might need different gold standard cut-offs for REM atonia in PSG. Further studies are needed in this field.

Compared to the previous report by Li et al. [15], the mean total scores in our study were a little higher than in theirs (case group: 38.40 ± 21.65 vs 32.1 ± 16.1; control group: 9.94 ± 10.29 vs 9.5 ± 10.2; this study vs Li et al., respectively). The explanation could be that most subjects (86.46%) in our study completed RBDQ-HK by themselves and their bed-partners; whereas most subjects (92.52%) in Li et al.'s study completed RBDQ-HK by the patients themselves.

Table 2
Comparison of the mean scores of the two factors and overall scale.

Groups	*n*	Age (years) Mean (SD)	Male No. (%)	Factor 1 Mean (SD)	Factor 2 Mean (SD)	Overall score Mean (SD)
Case groups	115	59.13 ± 15.7	78 (67.8%)	12.39 ± 7.67	26.01 ± 16.20	38.40 ± 21.65
Idiopathic RBD	48	50.90 ± 17.91	38 (79.17%)	12.19 ± 8.27	23.29 ± 15.89	35.48 ± 21.55
Symptomatic RBD	61	66.41 ± 8.34	38 (62.30%)	12.77 ± 7.21	29.30 ± 16.20	42.07 ± 21.54
RBD-like disorder	6	51.00 ± 19.80	2 (33.33%)	10.17 ± 8.11	14.33 ± 9.59[*]	24.50 ± 16.56[*]
Control groups	210	50.49 ± 16.3	144 (68.6%)	5.92 ± 5.08[a]	4.02 ± 7.09[a]	9.94 ± 10.29[a]
Parkinson disease	95	66.14 ± 9.35	62 (65.30%)	10.67 ± 7.38	21.96 ± 17.34	32.63 ± 23.15
Patients with RBD	61	66.41 ± 8.38	38 (62.30%)	12.77 ± 7.21	29.30 ± 16.20	42.07 ± 21.54
Patients without RBD	34	65.65 ± 11.02	24 (70.60%)	6.91 ± 6.17[b]	8.79 ± 10.05[b]	15.71 ± 14.96[b]
Obstructive sleep apnea syndrome	144	47.02 ± 14.94	121 (84.00%)	5.94 ± 5.34	6.60 ± 9.97	12.00 ± 13.24
Patients with RBD	30	48.27 ± 16.48	27 (90.00%)	9.00 ± 7.26	17.33 ± 13.49	26.33 ± 18.10
Patients without RBD	114	46.69 ± 14.57	94(82.50%)	5.14 ± 4.41[c]	3.09 ± 6.05[c]	8.23 ± 8.31[c]

SD, standard deviation; RBD, rapid eye movement behavior disorder.
[*] $P < 0.05$, there were statistical significances on mean score of factor 1, factor 2 and overall scale between symptomatic RBD group and RBD-like disorder group.
[a] $P < 0.001$, between case group and control group.
[b] $P < 0.001$, between PD patients with RBD and PD without RBD.
[c] $P < 0.001$, between OSA patients with RBD and without RBD.

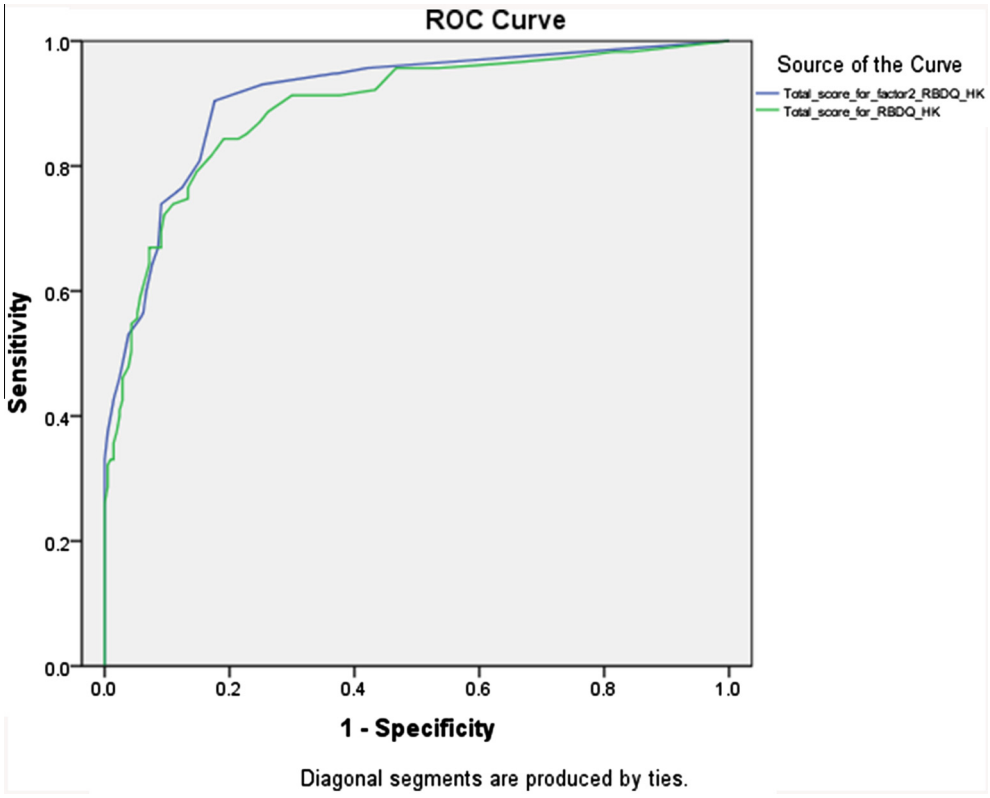

Fig. 1. Receiver operating characteristics (ROC) curve for all respondents to the REM Sleep Behavior Disorder (RBD) Questionnaire – Hong Kong (RBDQ-HK). The best cut-off for overall scale (green line) was located at 17 with a sensitivity of 84.34%, specificity of 80.95%, positive predictive value (PPV) of 70.80%, and negative predictive value (NPV) of 90.42% [area under the curve (AUC) = 0.892]. The best cut-off for factor 2 questions (blue line) was located at 7/8 with a sensitivity of 90.43%, specificity of 82.38%, PPV of 73.76%, and NPV of 94.02% (AUC = 0.911). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Li et al.'s study found that RBD-like disorder group had the highest score on factor 1 (dream-related factor), whereas all three subgroups had comparative scores on factor 2 (behavioral manifestation) and overall scale, suggesting a similar behavioral aspect of RBD in these three subgroups and a more disturbing dream aspect of RBD, which may be closely related to the underlying psychiatric illness and the psychotropic medications. By contrast, in our study the RBD-like disorder group had the lowest score on factor 2 in case subgroups, whereas all three subgroups had comparative scores on factor 1. The possible reasons may be sampling error owing to small sample size (number of RBD-like disorder patients, Li et al.'s study: $n = 27$; our study: $n = 6$) and drug influence. It has been suggested that some agents, particularly among the selective serotonin reuptake inhibitors (SSRIs) and selective norepinephrine reuptake inhibitors (SNRIs), may precipitate or aggravate RBD in some individuals [28,29]. In our study, since most RBD-like disorder patients had not yet taken SSRI and SNRI drugs, the RBD symptoms seemed not to manifest completely. Further studies are needed to confirm the closer association of RBDQ-HK factor scores in RBD subgroups.

RBDQ-HK was developed as a self-administered questionnaire, that is to say, people may complete the questionnaire by

Table 3
Cut-off values and validation coefficients for RBDQ-HK factor 2, overall RBDQ-HK in different clinical populations.

Clinical populations	Cut-off value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	AUC	*P*-value
All subjects							
Factor 2 of RBDQ-HK	7 or 8	90.43	82.38	73.76	94.02	0.911	<0.001
Overall RBDQ-HK	17	84.35	80.95	70.80	90.42	0.892	<0.001
PD patients							
Factor 2 of RBDQ-HK	13	83.60	76.50	87.39	65.63	0.861	<0.001
Overall RBDQ-HK	18	86.90	70.60	81.82	75.86	0.840	<0.001
OSA patients							
Factor 2 of RBDQ-HK	7	83.30	87.70	64.10	95.24	0.878	<0.001
Overall RBDQ-HK	17	70.00	86.80	52.50	91.35	0.850	<0.001

PPV, positive predictive value; NPV, negative predictive value; AUC, areas under the curve.

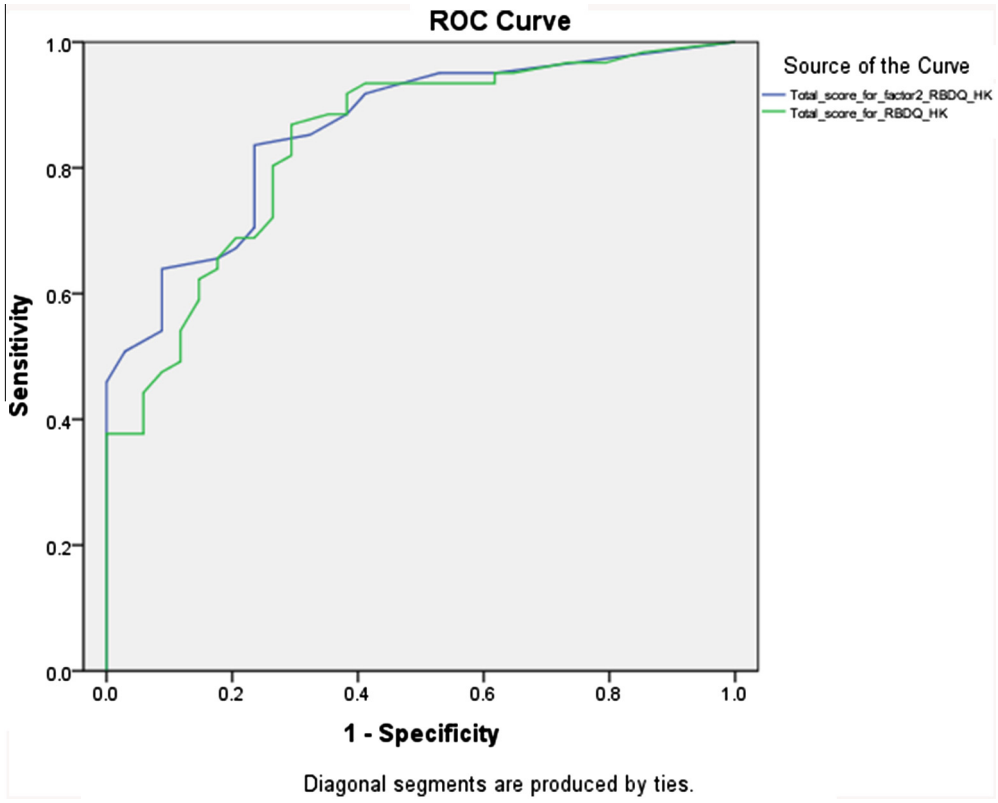

Fig. 2. Receiver operating characteristics (ROC) curve for PD patients responding to the REM Sleep Behavior Disorder (RBD) Questionnaire – Hong Kong (RBDQ-HK). The best cut-off for overall scale (green line) was located at 18 with a sensitivity of 86.90%, specificity of 70.60%, positive predictive value (PPV) of 81.82%, and negative predictive value (NPV) of 75.86% [area under the curve (AUC) = 0.840]. The best cut-off for factor 2 questions (blue line) was located at 13 with a sensitivity of 83.60%, specificity of 76.50%, PPV of 87.39%, and NPV of 65.63% (AUC = 0.861). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

themselves with or without their partner. However, at the beginning of our study, the patient's score of RBDQ-HK based on the patient's self-reports was compared to that provided by both himself and his bed partner, and a difference of 30 points was observed. Based on this huge difference, we suggest that RBDQ-HK should be completed by the patient and her/his bed partner together to improve accuracy. It should also be kept in mind that RBDQ-HK can be used not merely for screening RBD but also for screening AMBEs when applied in PD patients.

The present study has some limitations. First, according to the COSMIN (Consensus-based Standards for the selection of health status Measurement INstruments) guidelines, the quality of a measurement instrument is described by three quality domains: reliability (including internal consistency, reliability, and measurement error), validity (including content validity, construct validity, and criterion validity), and responsiveness [30,31]. Our study only addresses the first two domains – reliability and validity – and we did not test the responsiveness of RBDQ-HK. Second, the number of subjects is small and mostly from East China. It hardly represents the general population. Therefore, a large population and a different region of subjects are needed in the future study. Third, OSA is well known as a mimic of RBD; severe OSA/hypopnea can mimic RBD. To make sure that the OSA-RBD patients really had RBD, all definite OSA-RBD patients should have a second PSG test while using CPAP to eliminate 'pseudo-RBD'. In this study, 17 OSA-RBD patients with mild OSA were not CPAP-confirmed, but we had tried our best to eliminate the tone of apnea-associated arousals to reduce the error. Besides, we conducted structured interviews before the questionnaire survey, which may have generated potential bias due to patients' subjective impressions.

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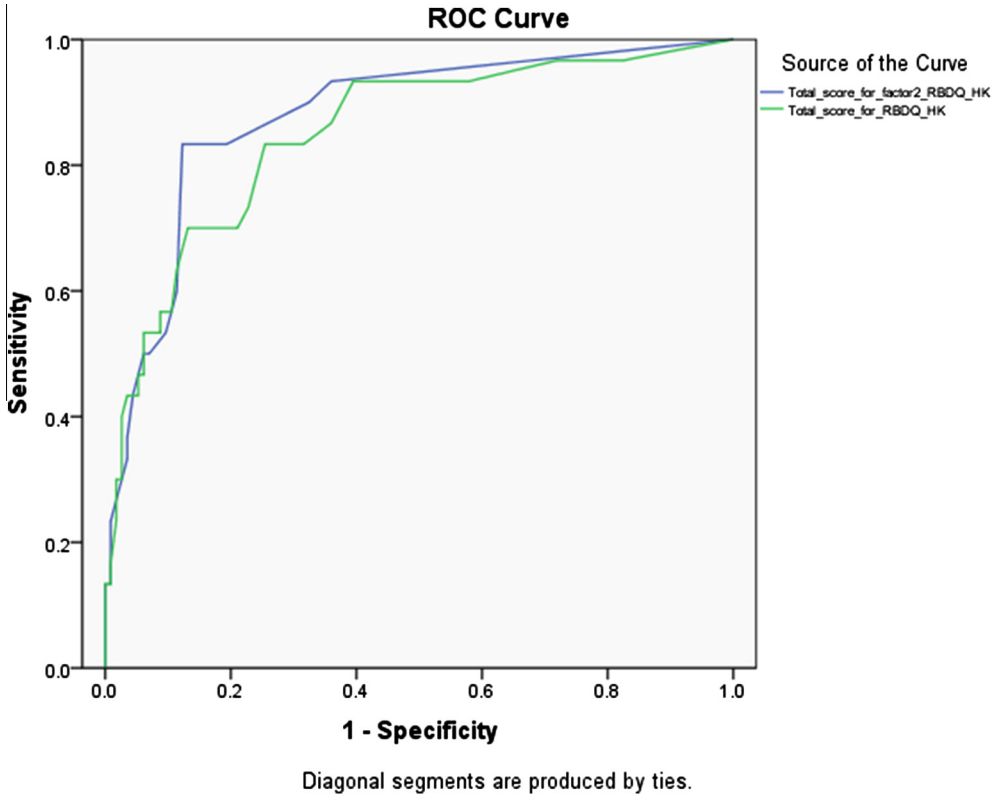

Fig. 3. Receiver operating characteristics (ROC) curve for OSA patients responding to the REM Sleep Behavior Disorder (RBD) Questionnaire – Hong Kong (RBDQ-HK). The best cut-off for overall scale (green line) was located at 17 with a sensitivity of 70.00%, specificity of 86.80%, positive predictive value (PPV) of 52.50%, and negative predictive value (NPV) of 91.35% [area under the curve (AUC) = 0.850]. The best cut-off for factor 2 questions (blue line) was located at 7 with a sensitivity of 83.30%, specificity of 87.70%, PPV of 64.10%, and NPV of 95.24% (AUC = 0.878). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2014.03.020.

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